DREDGED MATERIAL RESEARCH

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6 Dredged Material Research.

NOTES · NEWS · REVIEWS etc.

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Water quality standards may make it necessary to treat the effluent from some dredged material containment areas. The standards regulate both the amount of turbidity and the contaminant content. Since most contaminants are bound to the solid particles, removal or reduction of suspended solids will eliminate or minimize most water quality problems. Earlier small-scale studies indicated that chemical flocculation of containment area effluent was feasible for increasing the settleability of suspended solids. A full-scale test (photo above) was performed at a containment area in the Vicksburg District, and a significant reduction in effluent suspended solids was realized. Results of the field demonstration are described in the following article.

FIELD DEMONSTRATION OF EFFLUENT SUSPENDED SOLIDS REDUCTION BY FLOCCULATION AND SEDIMENTATION

*A. W. Ford**

Regulatory agencies often use turbidity and contaminant content as criteria for the water quality of the effluent discharged from dredged material containment areas. These criteria are usually met by simple confinement of the dredged material in diked areas for sufficient time for natural sedimentation processes to remove suspended materials, which effectively reduces both the turbidity and the contaminant level. When the effluent quality must meet more stringent requirements than can be achieved by this conventional method, some form of additional treatment must be used.

Laboratory and limited field studies performed during the Dredged Material Research Program (DMRP) indicated that chemical coagulation was effective in treating the effluent for additional suspended solids removal. Even though design and operation procedures for a chemical treatment system were developed, the concepts for implementing such a system were not field verified. A field-verification demonstration is described in the following paragraphs.

PURPOSE AND SCOPE

The demonstration was conducted in conjunction with a freshwater channel modification project in the Vicksburg District and was under the sponsorship of the Dredging Operations Technical Support (DOTS) Program with the support of the Vicksburg District. Significant contributions were made by Mr. J. O. Farrell and Mr. J. P. Stafford III of the District.

The major objectives were to demonstrate the effectiveness of synthetic polymers to flocculate and reduce suspended solids in containment area effluents and to develop practical operational procedures for chemical treatment. Prior to the field investigation, a number of commercially available chemicals were evaluated in the laboratory, and an inexpensive chemical dispersion system and a mixing system were designed.

Traditionally, treatment of containment area effluent requires a polymer feed system, a rapid-mix facility, a slow-mix facility, and a settling basin or clarifier with a detention time adequate to allow flocced material to settle. However, in many cases, this level of sophistication may not be practical or necessary to provide the required suspended solids removal. The field demonstration was a simple, inexpensive system designed to use existing field conditions as much as possible and the least amount of energy in the treatment plan.

SELECTION OF CHEMICALS

Laboratory jar tests (Figure 1) were performed to identify the most effective chemical and to determine the application rate for use in the field demonstration. Clay sediment from the site of the proposed dredging project was used in the laboratory tests. Analysis of the clay indicated that it was not contaminated.

Chemical injection rates were selected using two variables: anticipated effluent solids content and effluent flow rate, both based on data from monitoring previous dredging activities in the area. Suspended solids levels in the range of 0.5 to 2.0 g/ℓ were used to prepare slurry for the jar tests. The effluent flow from a containment area is relatively constant if the dredge operates continuously with a short amount of downtime. Since an 18-in. hydraulic dredge was scheduled for the dredging project, a flow rate of about 27 cfs was used to determine the injection rate for evaluating the chemicals.

Forty-seven candidate chemicals were considered for use in the demonstration. Twelve of the 47 were eliminated because of chemical similarities.

Screening criteria for the other 35 chemicals were established based on the optimum dosage and time required for flocculation and sedimentation. The more familiar potable water treatment chemicals were eliminated because excessive dosage rates were required to produce flocs. The surviving chemicals were

Figure 1. Laboratory jar tests

* *Ford is an Engineer assigned to the Water Resources Engineering Group in the Environmental Engineering Division of the WES Environmental Laboratory.*

all polyelectrolytes, and a high molecular weight liquid cationic polymer was identified as the best performer. This substantiated the DMRP findings that a positively charged polymer was more effective in a freshwater slurry than either an anionic or nonionic monomer or polymer.

CONTAINMENT AREA

The containment area designed for the dredging project is shown in Figure 2. The 48-acre containment area was constructed adjacent to a previously filled and abandoned 43-acre containment area (identified as primary and secondary disposal areas, respectively, in Figure 2). The primary disposal area was designed with a 120-ft fixed-crest weir in the south dike so that effluent would flow into the secondary area and return to the Yazoo River through box weirs. Construction of the containment area was almost complete when it was selected for the field demonstration, and only minor modifications were made to provide for chemical mixing and subsequent floc settling.

CHEMICAL TREATMENT SYSTEM

The basic features of chemical treatment include chemical injection, mixing, and settling. The chemical injection and mixing systems were incorporated into the weir structure of the primary disposal area so that the hydraulic head differential between the two disposal areas would provide the necessary energy for mixing and flocculating the suspended solids and also for maximum utilization of the remaining volume in the secondary basin for settling and storage.

Injection

The chemical injection system consisted of 1-in. PVC pipe mounted on steel stanchions and connected to a variable flow pump. The pump was calibrated to deliver dosage rates from 10 to 20 mg/ℓ. Small holes, drilled on 2-ft centers along the entire length of pipe, were oriented so that the chemical would be jetted into the effluent as it plunged over the weir. The injection system is shown in place above the weir in Figure 3.

Mixing

Energy was required to mix the polymer with the effluent so that flocculation would occur. Therefore, it was important that the design of the chemical mixing system utilize the energy available from the flow of effluent over the weir to the maximum extent possible.

A baffled channel mixer was designed as shown in

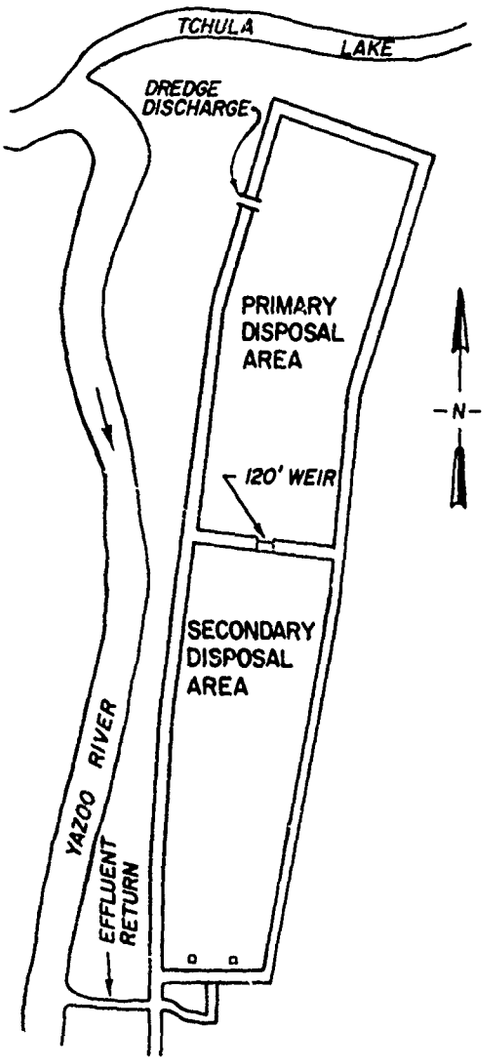


Figure 2. Site location and layout

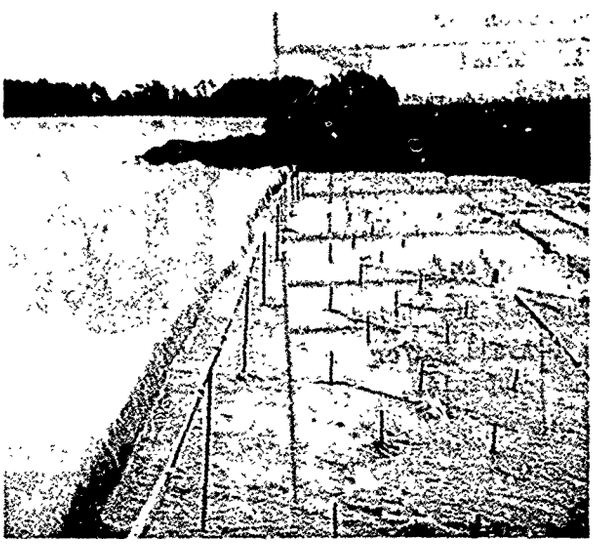


Figure 3. Chemical injection system

the cover photo. The concept was to increase the flocculant mixing time while promoting the most energy possible from the flow. The baffle system extended down the chute from the overflow weir, traversed the entire length of the weir, and extended 40 ft into the secondary basin. The 40-ft extension was constructed of concrete on a 1 vertical and 10 horizontal slope and had 8 rows of parallel baffles with staggered openings alternating between rows. Additional baffles were placed diagonally to further increase mixing potential.

The effectiveness of the baffled mixing system was evaluated by injecting dye at the weir overflow point and observing the dispersion of the dye through the baffled system. This test indicated that good mixing of the polymer and the effluent could be expected.

Settling

The secondary disposal area (Figure 2) was used as a settling basin for separation of the flocculated solids from the effluent of the primary disposal area before the effluent was discharged into the Yazoo River. Although about 43 acres in surface area, the site was almost filled with dredged material from previous projects, and very little retention volume remained. Time did not allow for modification of this area for ideal settling conditions. Some erosion of the original dredged material deposit during the field tests was observed at the outlet box weirs (Figure 4) from the secondary basin, which contributed solids to the effluent returning to the Yazoo River. However, the secondary basin was considered adequate to provide removal of a significant amount of the solids from the treated effluent.

DEMONSTRATION RESULTS

Two demonstration tests were performed: a test of short duration to determine the effectiveness of the injection and baffled mixing systems and the design concept and a test of longer duration to test the efficiency of the injection-mixing-settling system to reduce the suspended solids in the effluent.

The short-duration test (3 hr) was evaluated by performing column tests in the field using untreated effluent and samples of the treated effluent after it passed through the baffle system. The batch settling tests indicated that the system was highly effective in mixing the chemical flocculant with the effluent. Figure 5 shows typical results of batch settling tests performed in the field, and Figure 6 shows a comparison of untreated and treated effluent samples. The batch settling tests indicated that the chemically flocculated effluent solids would settle within a few minutes. The untreated solids had not settled in the primary basin, which had a retention time of several days.

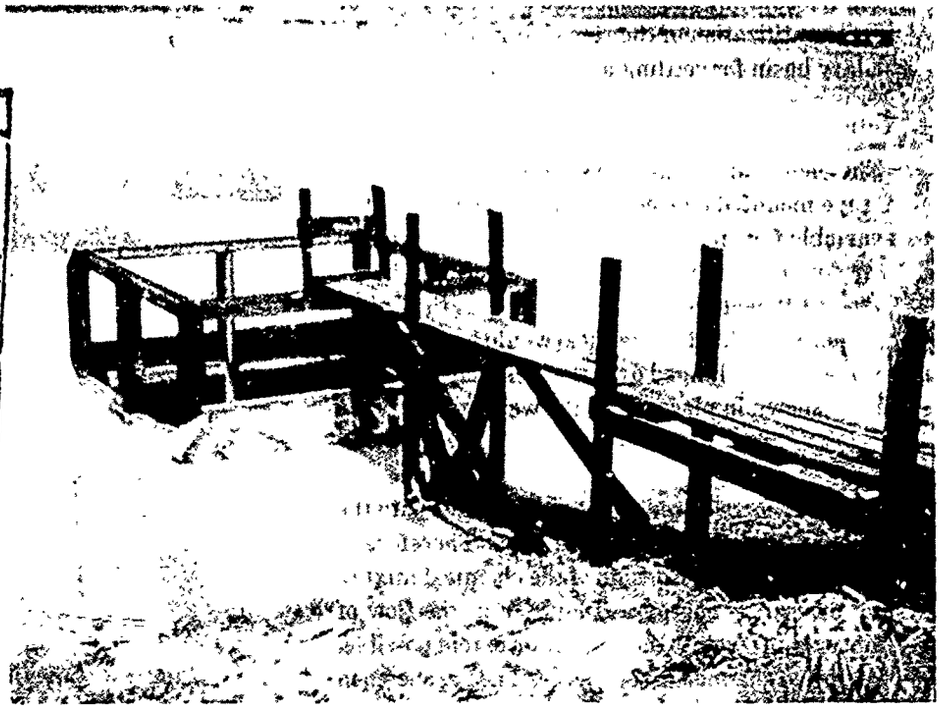


Figure 4. Box outlet weir from secondary basin

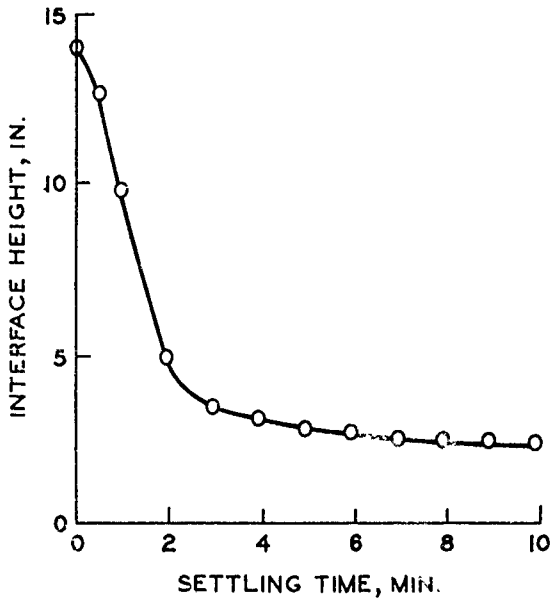


Figure 5. Settling rate of solids in treated effluent measured in a 1-litre graduated cylinder

The long-duration test (28 hr) indicated that polymer mixed with the containment area effluent resulted in a significant reduction of suspended solids returning to the receiving stream. The effluent from the secondary basin averaged 3.75 g/ℓ suspended solids before the injection period began. At the conclusion of the demonstration, the effluent averaged 0.475 g/ℓ suspended solids. It is likely that the suspended solids in the effluent from the secondary basin could have been reduced even further if the polymer had been applied for longer periods and if the basin had been modified to provide adequate ponding for sedimentation.

CONCLUDING REMARKS

The results from the field demonstration indicate that chemical treatment is effective in reducing effluent suspended solids from dredged material containment areas. However, this treatment is recommended only for cases where primary sedimentation does not provide adequate removal of suspended solids.

The demonstration also verified that sufficient energy is available from flow over a weir to provide adequate mixing of chemical flocculant and effluent. In this demonstration, the energy was effectively used by simply modifying the weir chute to provide a baffle system. It is believed that other types of weir outlets could also provide sufficient energy to mix the chemicals being used to flocculate the effluent solids.

The cost of the chemical injection was about $80 per hour of dredging (1979 dollars). This cost does not include the construction of the baffled mixing system.

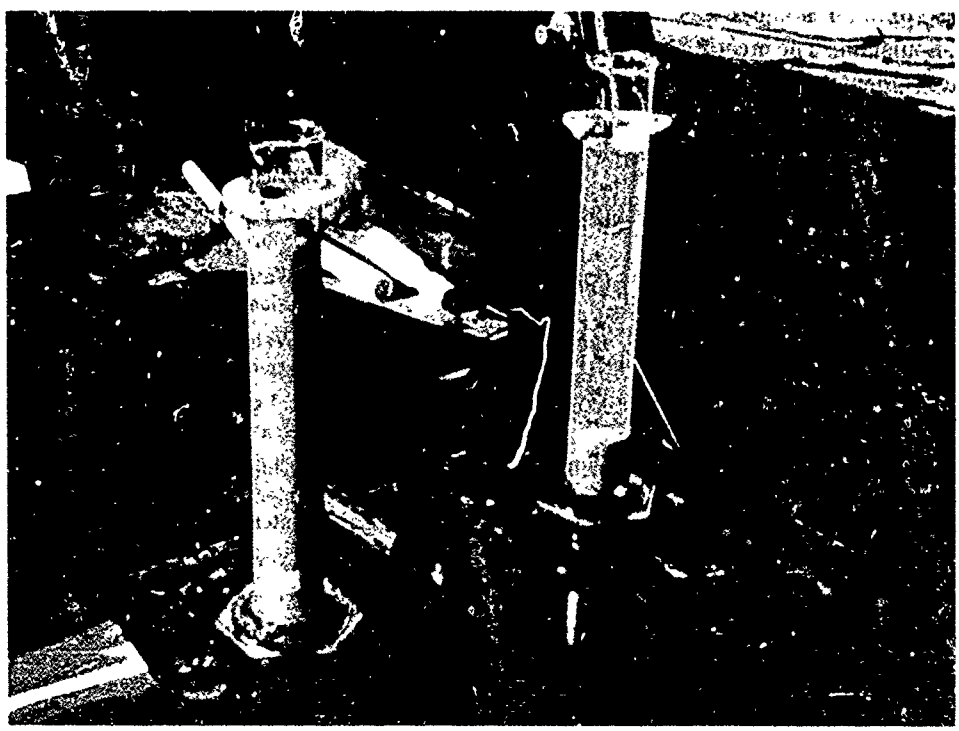


Figure 6. Batch settling tests of untreated and treated effluent samples

SHOW AND TELL

"The DMRP—Highlights of Results," a 15-minute cassette/slide briefing prepared for and approved by OCE, has been furnished to each CE District and Division Engineer. The briefing describes the major accomplishments of the DMRP and the scope and objectives of DOTS. In addition to the copies sent to DEs, the briefing is available on loan. Requests should be addressed to

Commander and Director
U. S. Army Engineer Waterways Experiment Station
ATTN: WESTP
P. O. Box 631
Vicksburg, Mississippi 39180

or telephone

Commercial 601-634-2571
FTS 542-2571

FIFTH U. S./JAPAN MEETING

The Fifth U. S./Japan Meeting on Management of Bottom Sediments Containing Toxic Substances was held recently in New Orleans, Louisiana. The meeting is held annually through an agreement with the U. S. Environmental Protection Agency and the Japan Ministry of Transport to provide a forum for presentation of papers and in-depth discussions on dredging and disposal of contaminated materials.

The Corps of Engineers has participated in each of the five annual meetings. Much of the information presented by the Japanese representatives has been directly applicable to problems experienced in the United States.

Through the courtesy of the Corps of Engineers' New Orleans District, the Gulf Coast Dredging Association, and the Board of Commissioners, Port of New Orleans, field trips were made to observe various dredging activities in the area.

The list of participants is shown in Table 1, and the list of papers presented is shown in Table 2. Preprints of the papers for this meeting, as well as the proceedings from the Fourth meeting, are available from Dr. Spencer A. Peterson, Corvallis Environmental Research Laboratory, U. S. Environmental Protection Agency, 200 S.W. 35th Street, Corvallis, Oregon 97330.

Table 1
PARTICIPANTS IN U. S./JAPAN MEETING

Name	Organization
Japanese Delegation	
Rikuro Takata Co-Chairman	Bureau of Ports and Harbours Ministry of Transport
Noriyoshi Aritomi	Japan Dredging and Reclamation Engineering Association
Masahiro Fukushima	Japan Bottom Sediment Management Association
Mitsumasa Okada	National Institute for Environmental Studies
Hiroshi Ueda	Bureau of Ports and Harbours Ministry of Transport
Tatsuo Yoshida	Japan Bottom Sediment Management Association
U. S. Delegation	
James C. McCarty Co-Chairman	EPA, Corvallis Environmental Research Laboratory
Charles C. Calhoun	CE, Waterways Experiment Station
Italo A. Carcich	New York State Department of Environmental Conservation
John Crowder	EPA, Washington
Russell Dunst	Wisconsin Department of Natural Resources
Carl Hakenjos	Williams-McWilliams Dredging Company
Ronald E. Hoeppel	CE, Waterways Experiment Station
COL Maximilian Imoff	CE, Commander/Director Water Resources Support Center
C. R. Lee	CE, Waterways Experiment Station
Raymond L. Montgomery	CE, Waterways Experiment Station
Michael D. Mullin	EPA, Large Lakes Research Station
William R. Murden	CE, Chief, Dredging Division Water Resources Support Center
C. J. Nettles	CE, New Orleans District
Spyros P. Pavlou	URS Company
Spencer A. Peterson	EPA, Corvallis Environmental Research Laboratory
Russell E. Plumb, Jr.	Great Lakes Laboratory

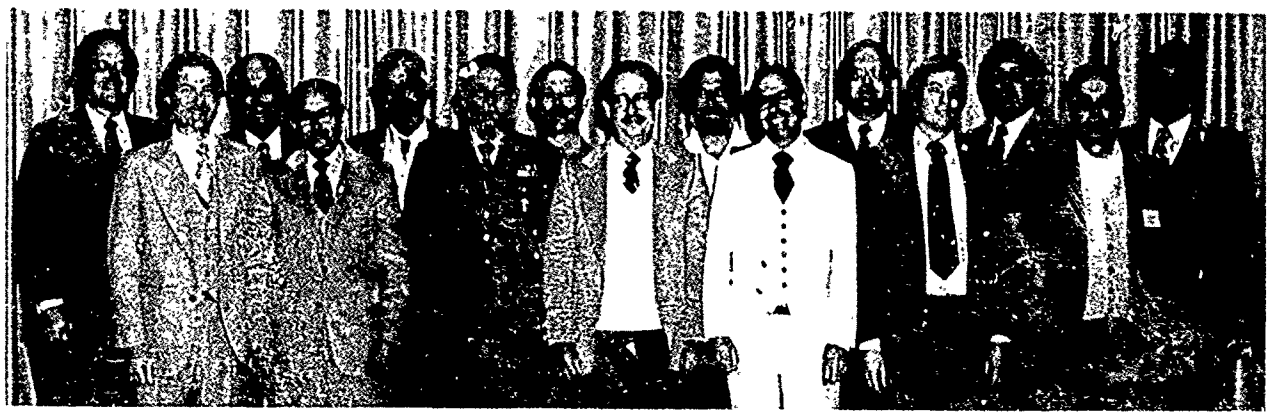
Table 2

PAPERS PRESENTED AT U. S./JAPAN MEETING

Paper Title	Presentor
Dredging on a Competitive Basis	Murden
Sea Bottom Management in Japan	Takata
Control of Toxics in the U. S.	McCarty
Availability and Plant Uptake of Heavy Metals from Contaminated Dredged Material Placed in Flooded and Upland Disposal Environments	Lee
Distribution and Concentration of PCB in the Hudson River and Associated Management Problems	Carcich
The "404" Dredge and Fill Program	Crowder
Sediment Problems and Lake Restoration in Wisconsin	Dunst
Release of Phosphorus from Lake Sediments	Okada
PCB Dredging and the Effects of Open Water Disposal	Pavlou
Contaminant Mobility in Diked Containment Areas	Hoeppel
Mathematical Modeling of Phosphorus Release from Lake Sediments	Yoshida
Containment Area Design for Sedimentation of Fine-Grained Dredged Material	Montgomery
Sediment Sampling, Preservation and Analysis: State-of-the-Art Limitations	Plumb

DOTS PROGRAM REVIEW

A review of the DOTS Program was recently held at WES Environmental Laboratory (EL) to update various agencies on regulatory functions research, long-term monitoring of DMRP field sites, and verification and refinement of engineering technology developed during the DMRP. Also, an overview of problems being addressed through the DOTS assistance function was presented. The review was attended by representatives from the Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), U. S. Fish & Wildlife Service, as well as by Corps representatives from the Office, Chief of Engineers (OCE), Water Resources Support Center (WRSC), Lower Mississippi Valley Division (LMVD), and the New Orleans District (NOD). Some of the participants are shown in the photo.



Front Row (from left): Dr. Robert M. Engler, EL; Mr. William W. Curtis, LMVD; COL Maximilian Imhoff, Commander/Director, WRSC, Dr. John Harrison, Chief, EL; Mr. Rixie J. Hardy, NOD; Mr. Frank Torbett, OCE; and Mr. Donald R. Letzkus, WRSC. **Back Row:** Mr. Charles C. Calhoun, Program Manager, DOTS, EL; Mr. William R. Murden, Chief, Dredging Division, WRSC; Dr. Kilho Park, NOAA; Mr. Thomas R. Patin, DOTS, EL; Mr. T. A. Wastler, EPA; Dr. R. T. Huffman, EL, Dr. Raymond L. Montgomery, EL, and Dr. Thomas D. Wright, DOTS, EL.

NEW LITERATURE

BHRA Fluid Engineering. 1977. "Second International Symposium on Dredging Technology at Texas A&M University, U.S.A., 1977," Vols. 1 and 2, Cranfield, Bedford, U.K.

The Second International Symposium on Dredging Technology was organized by BHRA Fluid Engineering in association with Texas A&M University and was held at Texas A&M University on 7-9 November 1977. Volume 1 contains the papers presented at the Symposium. An edited record of the discussions and contributions to the papers is presented in Volume 2.

Upper Mississippi River Basin Commission (Co-Sponsors: GREAT and Western Dredging Association). 1979. "A Better Way of Doing Business . . . Dredging: the Challenge, the Technology, the Opportunity," *Symposium Proceedings*, Information Bulletin Number 6, 7920 Cedar Avenue South, Minneapolis, Minn. 55420.

Under The Challenge, papers are presented on dredging in the United States, dredging the Mississippi River, and government regulations of dredging. The Technology papers describe mechanical, hydraulic, and foreign dredges as well as fluvial hydrology as related to successful dredging. The reported work sessions (The Opportunity) include discussions on polluted material and marginally acceptable disposal sites; high volume, fast developing shoals; congested urban areas; shallow face of cut and long distance to disposal site; and crossing wetlands/no upland disposal area available.

NOTE: The DOTS Program regrets it cannot be a distributing agent for the new items of literature listed in this bulletin. All items presented are available at the time of listing from the publishing or issuing agency and requests for copies should be addressed to them. In many instances, only limited copies are available and the use of Interlibrary Loan or related services is encouraged.

This bulletin is published in accordance with AR 310-2. It has been prepared and distributed as one of the information dissemination functions of the Environmental Laboratory of the Waterways Experiment Station. It was published during the conduct of the Corps of Engineers' nationwide Dredged Material Research Program (DMRP) to disseminate program results rapidly and widely to Corps District and Division offices, as well as other Federal agencies, state agencies, universities, research institutes, and individuals. The DMRP was completed in March 1978, but the bulletin will be published under the Corps' Dredging Operations Technical Support (DOTS) program as part of the program mission to continue information dissemination and to assist in implementation of DMRP results. The bulletin will be issued on an irregular basis as dictated by the quantity and importance of information available for publication. Contributions of news, notes, reviews, or any other type of information are solicited from all sources and will be considered for publication as long as they are relevant to the DOTS theme of providing definitive information on the environmental impact of dredging and dredged material disposal operations and the development of technically satisfactory, environmentally compatible, and economically feasible dredging alternatives, including consideration of dredged material as a manageable resource. Special emphasis is placed on material relating to application of research results or technology to specific project needs. Communications are welcomed and should be addressed to the Environmental Laboratory, ATTN: Mr. C.C. Calhoun, Jr., U.S. Army Engineer Waterways Experiment Station, P.O. Box 631, Vicksburg, MS 39180, or call AC 601/634-3428 (FTS 542-3428).

NELSON P. CONOVER
Colonel, Corps of Engineers
Commander and Director